CHRISTMAS EVE, 1983, FOEHN WINDS OVER SOUTHEAST ALASKA

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ABSTRACT

The meteorological conditions leading up to and continuing throughout an unusual foehn wind outbreak across southeast Alaska were examined. Although the extensive warm air mass associated with these winds was aloft during much of its trek over Alaska and northwest Canada and, therefore, not trackable using surface data, indications of its strength and location were available using standard National Weather Service products.

1. INTRODUCTION

How many times have we forecasters discounted a feature we see pictured on a map or prognostic chart because it is "insignificant?" It is probably true that, in most cases, such assumptions are quite valid. However, once in a while such a decision can backfire, resulting in a very bad forecast. This is especially true when the weather caused by the "insignificant" feature a) occurs only very rarely, or b) is not visible on a satellite picture or from surface observations.

Such a phenomenon occurred just before Christmas, 1983, in Southeast Alaska. From early morning on the 23rd through the 25th of December, foehn winds spread over this part of the state, lifting temperatures by up to 30 degrees F. Such winds do not happen frequently in Southeast Alaska. It is rare for warm air to remain intact long enough while travelling over the ice and snow of Alaska, the Canadian Northwest Territories, and the southern Artic Ocean so that it can affect this region.

During the subject period, however, that is what happened. This study will try to reconstruct the meteorological events of the days leading up to the phenomenon, attempt to explain why it occurred, and point out, using currently available products, some of the keys which may help in forecasting future episodes.

2. DISCUSSION

Between 17 and 19 December, 1983, warm air carried by a deep Low moving north from the western Pacific, developed a large high-pressure ridge over the Alaska mainland extending southeast to a standing long-wave ridge situated off the west coast of the contiguous United States (Fig. 1). The surface reflection of this Low moved into the Bering Sea on December 18. By early on the 19th it was a stalled, vertically stacked system located just east of the Kamchatka Peninsula.

As the Low stalled it parented a disturbance near the end of the Alaska Peninsula. This offspring ascended into southwest Alaska shortly before 00Z on December 20th (Figs. 2 and 3). Coincidentally, two rather weak 500-mb troughs were descending on the eastern side of the ridge (Fig. 3). The combination of these tilted the ridge of high pressure, making its axis lie almost parallel to the 145° longitude line. Also, the switch from northwest to northerly flow over the western Canadian Rocky Mountains spawned a weak Low in southern British Columbia with a trough extending westward over Vancouver Island. This trough was enhanced and maintained by the subsequent cold air flow from the Canadian interior.

By 00Z on December 22 the remains of the frontal system, so apparent on the surface analysis 2 days earlier, were gone (Fig. 4). The air mass was still in evidence aloft, however, seen as a weak area of positive vorticity advection (PVA) located in extreme northwest Canada about 67° north latitude (Fig. 5).

The effects of this air mass are visible along the Alaskan North Slope as a warm bulge evident at 850-mb caused by downslope warming north of the Brooks Range (Fig. 6). (Figures 7 and 8 show the 850-mb temperature patterns over the 24 hours preceding the onset of this bulge. As there is no indication in these temperature fields of warm advection widespread or strong enough to cause these changes, it seems likely that the downslope mechanism caused the warming.) The pocket denoted by the 5° isotherm remained stationary for 2 days before fading away to the southeast. This gives a good clue as to the horizontal extent of the warm advection. At this time the Whitehorse (YXY) sounding showed the temperature at 850 mb to be -10°C.

Figure 9 shows the pressure gradient from YXY to Juneau (JNU) as a function of time. It is obvious that a weak trough passed YXY about 15Z on December 22nd. This is consistent with the passage of a weak 500-mb trough (weak PVA area) on the limited fine mesh (LFM) 20/1200Z analysis. The YXY RAOB at this time confirms this with a strong warm air intrusion at 850-mb (Fig. 10). Since little change is seen in the surface temperature at this time, it is obvious that the warm air was flowing along the top of the cold surface inversion and, as such, could not be tracked using surface data. Also, it is obvious that such warming is due to advection and not some subsidence, as no drying is evident from the sounding. Conversely, the dew-point temperatures actually showed a moistening trend.

A startling change in air flow is apparent between 12Z December 22nd and 00Z December 23rd on the polar orbiting satellite pictures shown in figures 12 and 13. Also, these photographs show a great expansion of the sea stratus over the eastern Gulf of Alaska. In figure 12 only a small patch of these clouds can be seen near Yakutat. In figure 13 this has expanded to near Sitka. Such a growth occurs frequently under subsiding air, a conclusion that is verified by the leap in the 0° isotherm at 850-mb from near Kodiak Island at 22/1200Z to offshore Yakutat at 23/0000Z. The 23/0000Z LFM analysis shows that the weak PVA area has moved south of the Panhandle and is about to merge with the trough off Vancouver Island.

By 23/1200Z, this merging has enhanced the strength of the Vancouver trough further cutting off the 500-mb High over the Alaska mainland and extending the surface trough northward over the eastern Gulf. The YXY sounding at that time shows the 850-mb temperature to be near 0°C, another 5-degree warming over the preceding 24-hour period. The 23/0000Z YXY sounding was not available to the author, so the exact distribution of such warming is not known. It is assumed, however, that most of this occurred from 22/1200Z until 23/0000Z, the time of maximum warm advection.

The potential warming of this air was amazing for winters in Alaska. Since 850-mb is about the height of the coastal mountains, which implies little if any condensation as the air mass crossed this barrier, lowering the air to the surface entails only adiabatic warming. Thus, surface temperatures of near 65°F were possible over the Gulf.

The warm air pocket continued in this area through much of Christmas Day, 1983. However, it was almost 24 hours after onset before warming was seen at any of the surface observing stations, all of which are sited along the coast (Fig. 14).

Between 23/1200Z and 25/1200Z the surface pressure gradient between YXY and JNU greatly increased, primarily due to the trough over the Gulf. The warm 850-mb air remained intact during this entire time. Thus, when the pools of cold surface air along the lee (ocean) sides of the mountains finally were eroded away, the warmth was still available aloft to cause the foehn.

Observation stations were quite disparate as far as the timing of the warming. At the National Weather Service Forecast Office in downtown Juneau, 20-degree temperature increases occurred early Saturday morning December 24th. Sitka warmed 13 degrees during that evening. Yakutat showed an increase from 19° to 39°F between 23 and 24 AKST on December 24th. JNU warmed almost 10 degrees in 1 hour around 9 AM on Christmas Day.

The proximity of the Mendenhall Glacier to the Juneau airport and the airport sheltered location undoubtedly had a great effect on delaying the onset of the foehn at that station. On Saturday morning when temperatures of almost 50°F were seen in downtown Juneau, temperatures in the teens were observed at the airport. However, a pilot flying over the airport at 3000 feet reported outside temperatures of 50°F.

3. CONCLUDING REMARKS

Hindsight is one of those great things enabling people to see what could or should have been done. Using such vision, however, may help us in the future. The following are some ideas drawn from this episode which may direct future forecasters down the correct path. These remarks are based on studies of surface, 850-mb, 700-mb, and 500-mb analyses; upper air soundings from the Yukon Weather Center in Whitehorse, Yukon Territory; polar orbiting NOAA 7 and 8 satellite photographs; and southeast Alaska and Canadian surface observations from 17 to 25 December 1983.

a) Watch those "weak" vorticity areas. They may be more meaningful than they appear. (The LFM charts handled this system rather well. See Figure 15 as an example, comparing it with Fig. 5.)

b) A warm air pocket north of the Brooks Range may give southeast Alaska forcasters a clue as to the strength and extent of warm air masses that could affect that area.

c) The YXY sounding gives valuable clues, not only to the potential for Taku winds, but also for foehn winds. The 850-mb level is especially important, apparently, with respect to these clues.

d) The extent of a warm air mass must be quite large, it appears, for foehn winds to actually affect the populated sections of southeast Alaska. Time is needed for these warm winds to erode away the surface cold air pools. If the warm air mass is not vast enough, the warming will be seen over the ocean but not where people are.

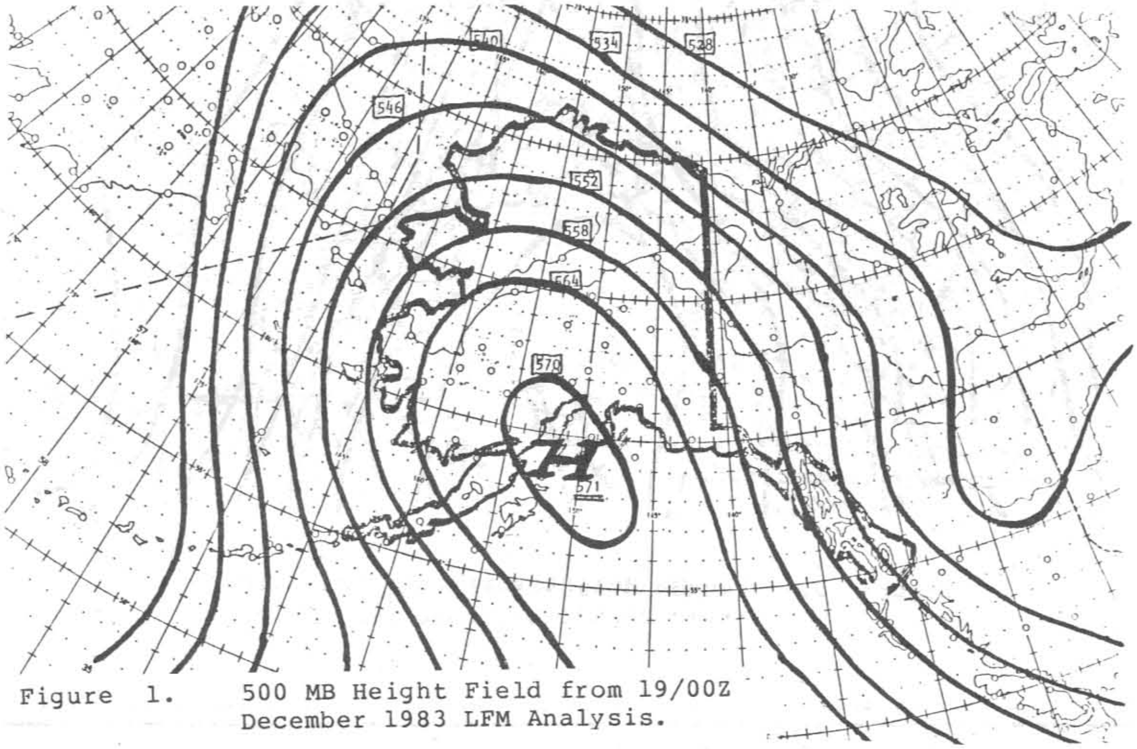

Figure 1. 500 MB Height Field from 19/00Z December 1983 LFM Analysis.

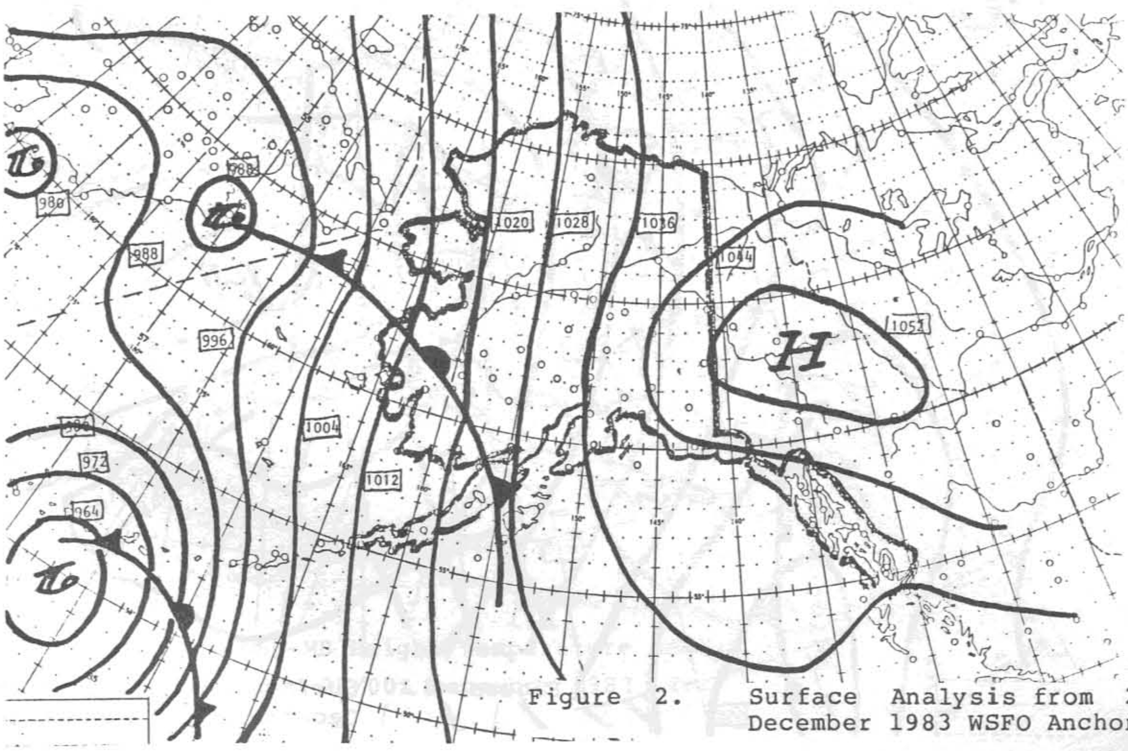

Figure 2. Surface Analysis from 20/00Z December 1983 WSFO Anchorage.

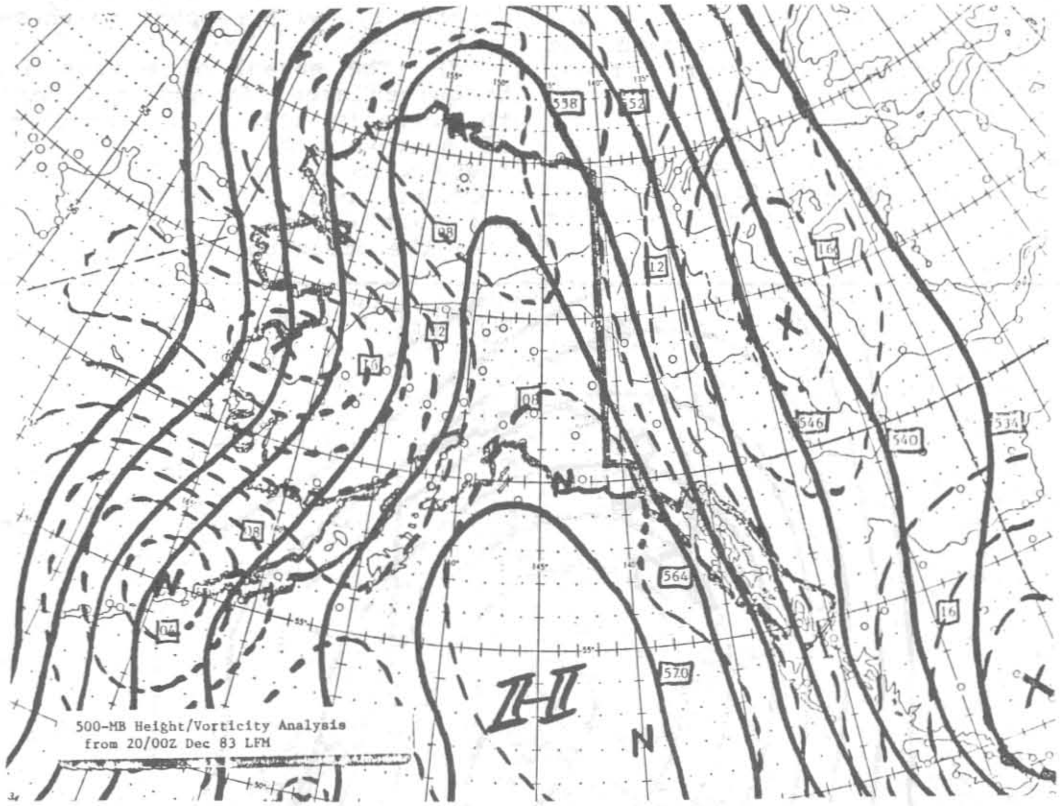

Figure 3. 500-MB Height/Vorticity Analysis from 20/00Z December 1983 LFM.

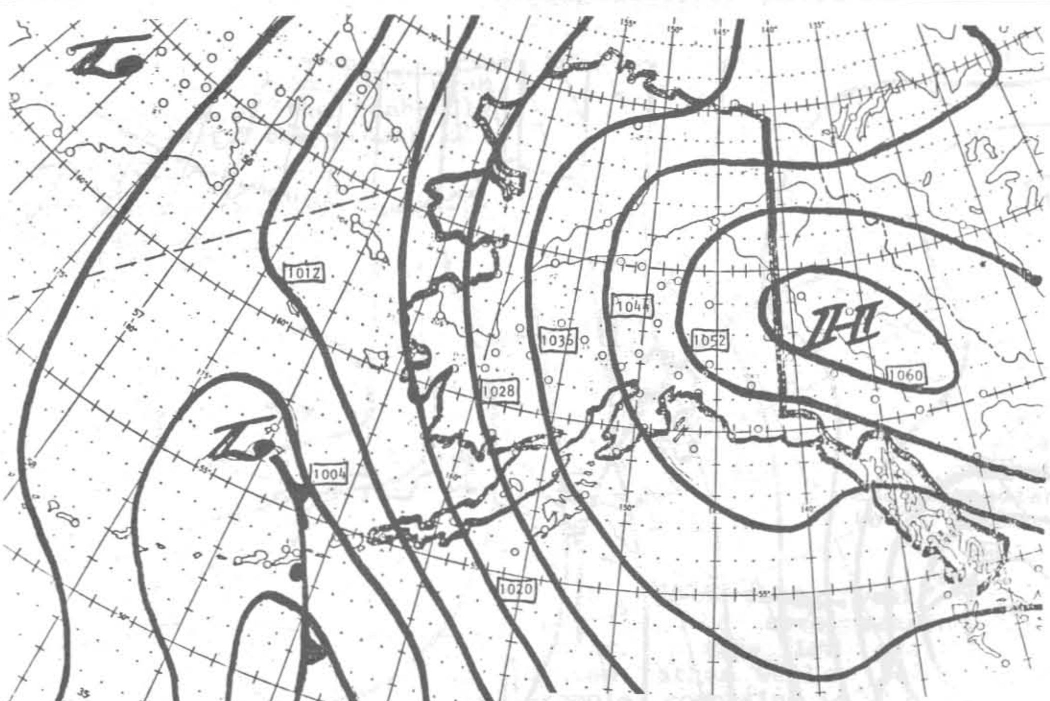

Figure 4. Surface Analysis from 22/00Z December 1983 WSFO Anchorage.

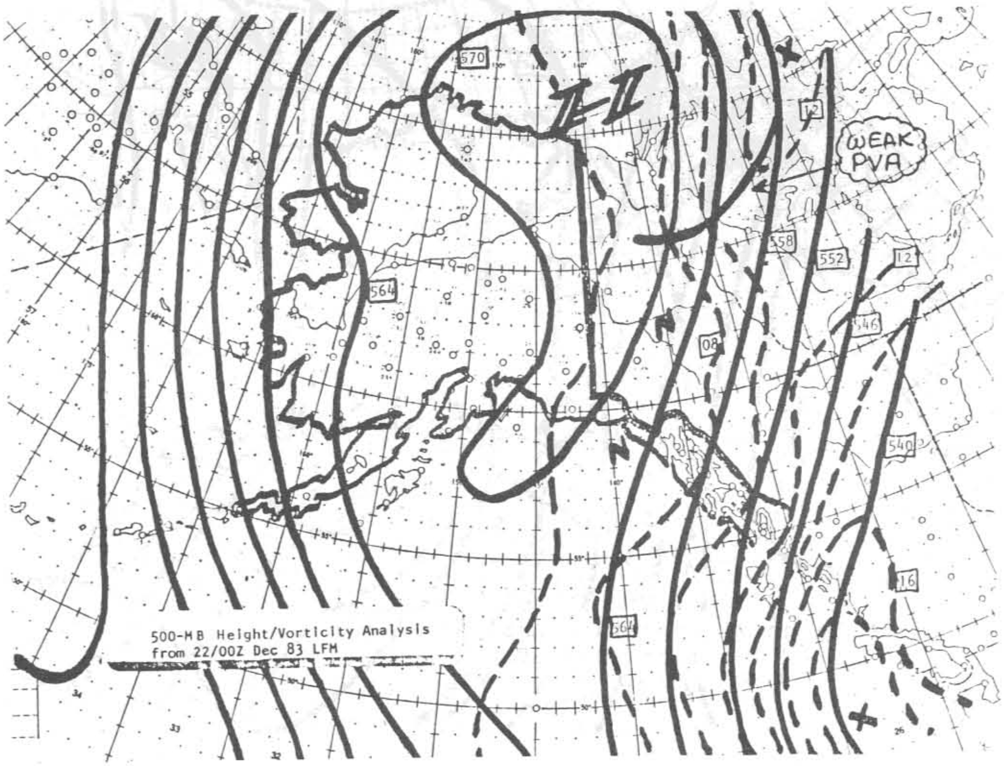

Figure 5. 500-MB Height/Vorticity Analysis
from 22/00Z December 1983 LFM.

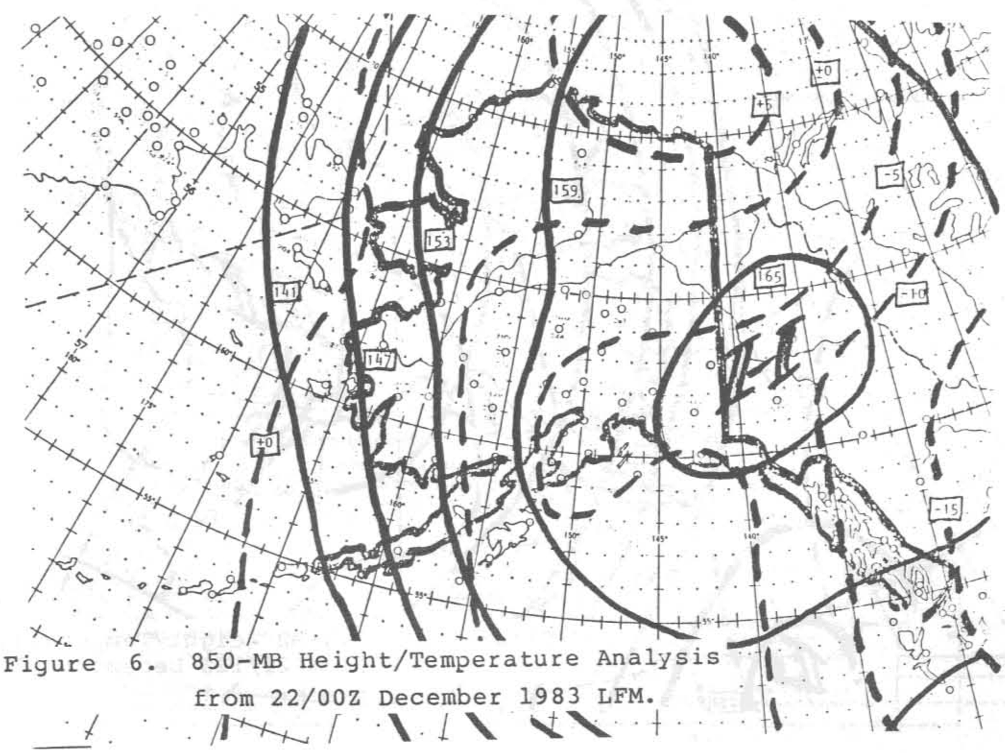

Figure 6. 850-MB Height/Temperature Analysis
from 22/00Z December 1983 LFM.

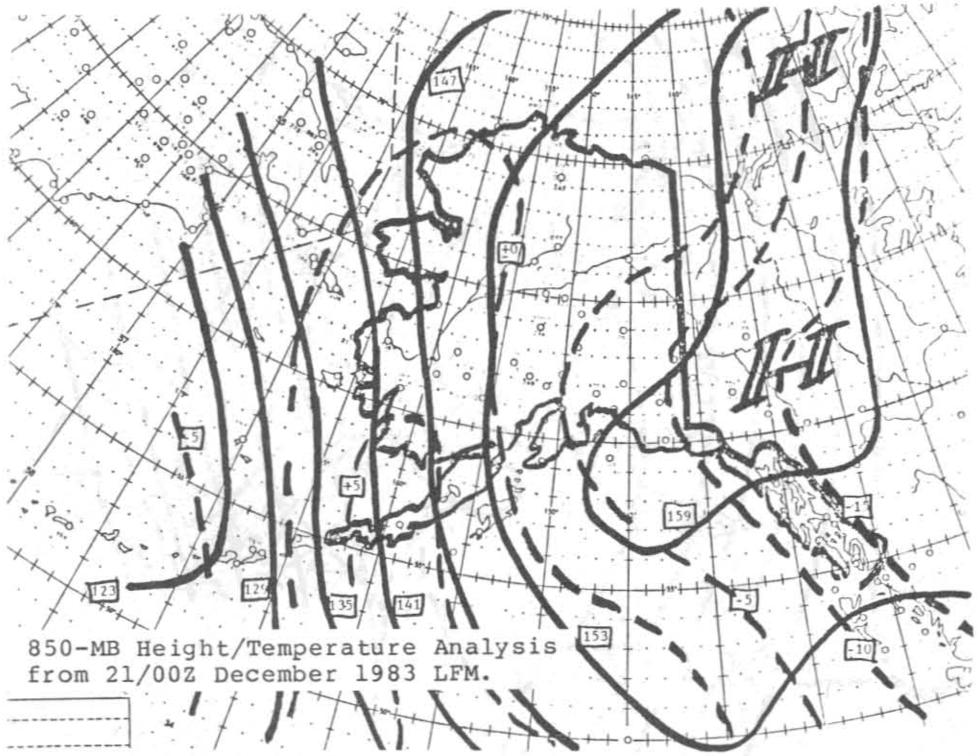

Figure 7. 850-MB Height/Temperature Analysis from 21/00Z December 1983 LFM.

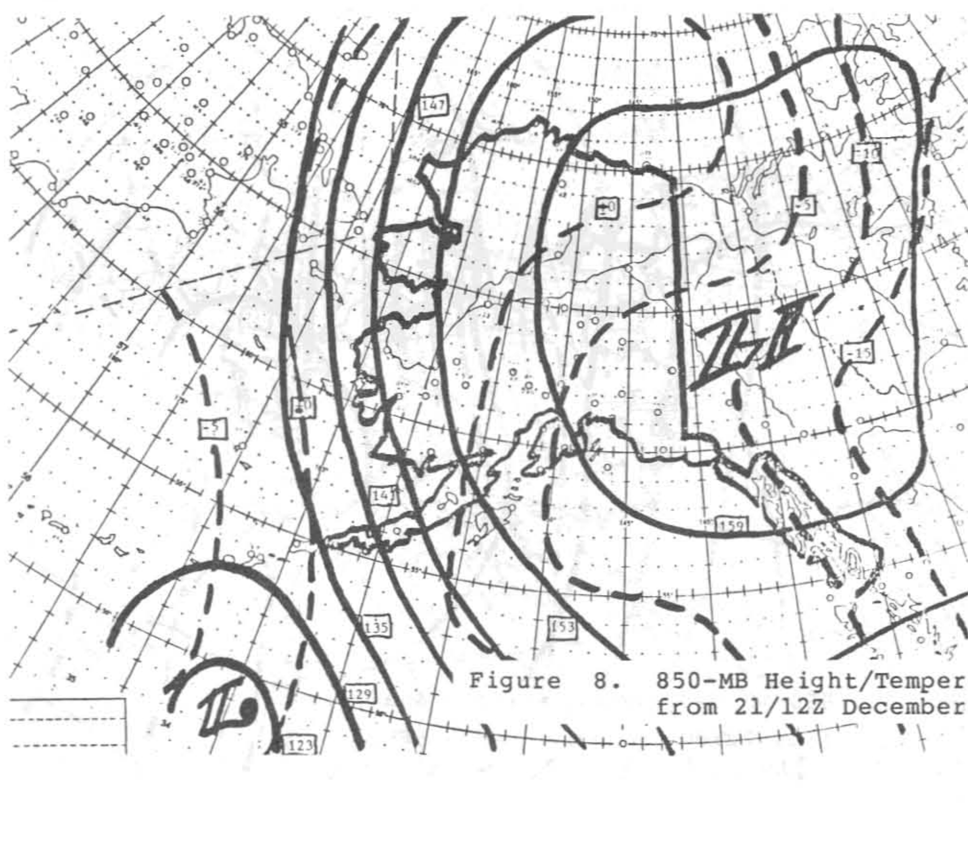

Figure 8. 850-MB Height/Temperature Analysis from 21/12Z December 1983 LFM.

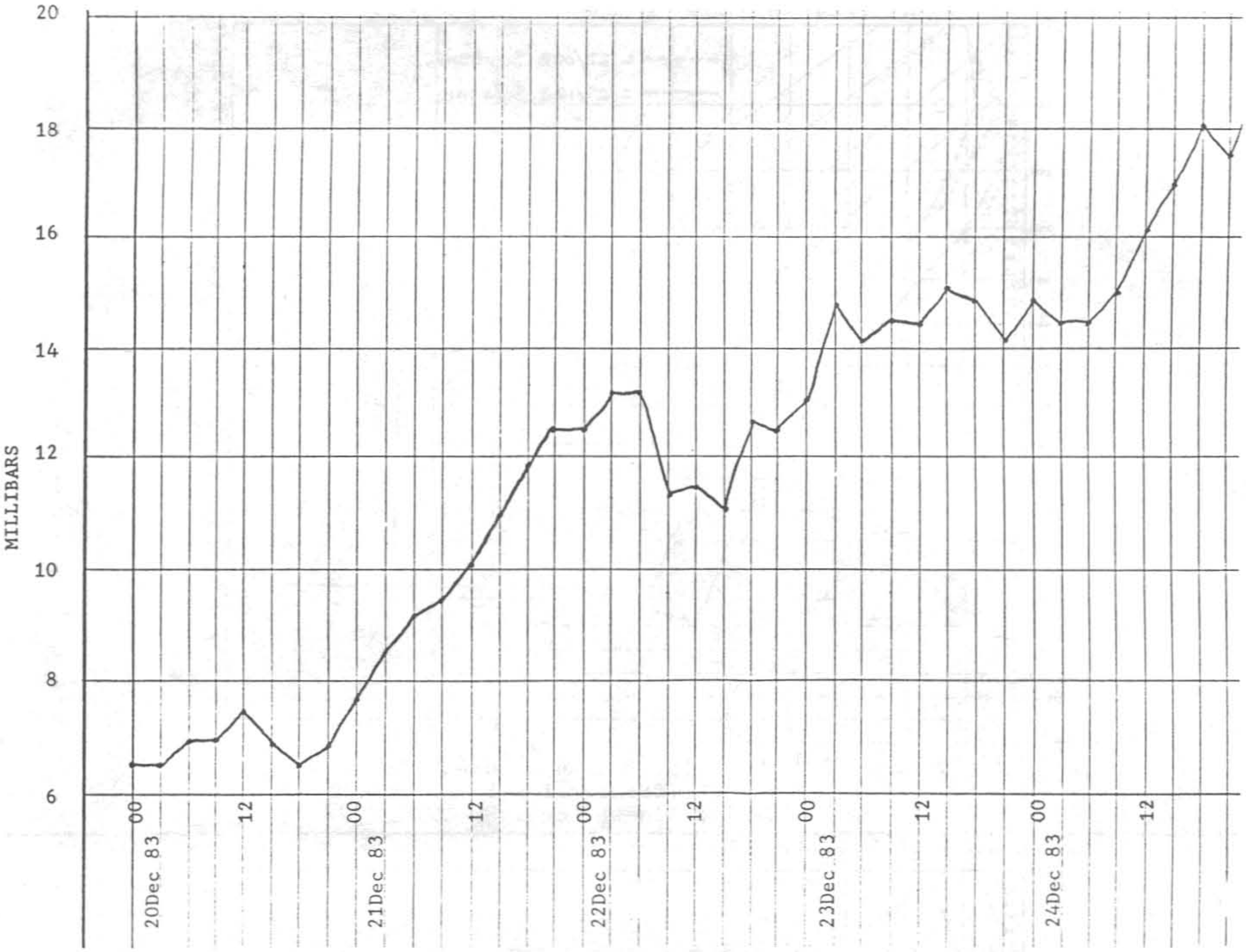

Figure 9. Whitehorse-Juneau pressure gradient vs. time cross section.

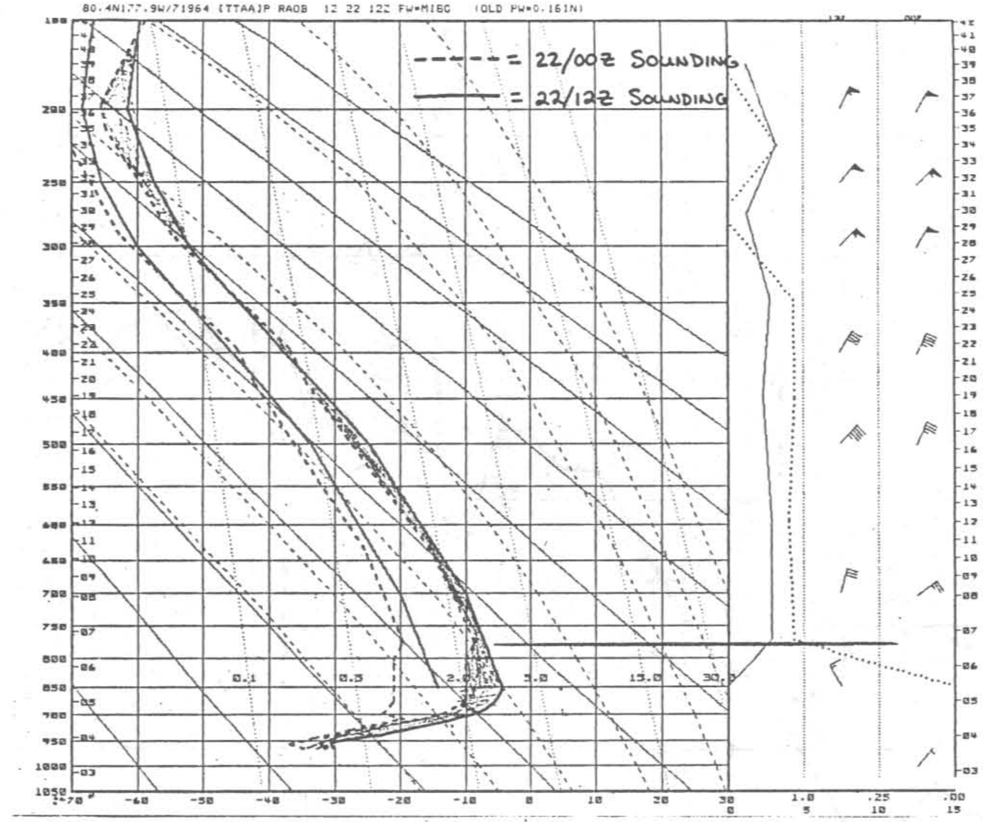

Figure 10. RAOB plot for Whitehorse (YXY), 22/00Z (dashed lines) and 22/12Z (solid lines) December 1983.

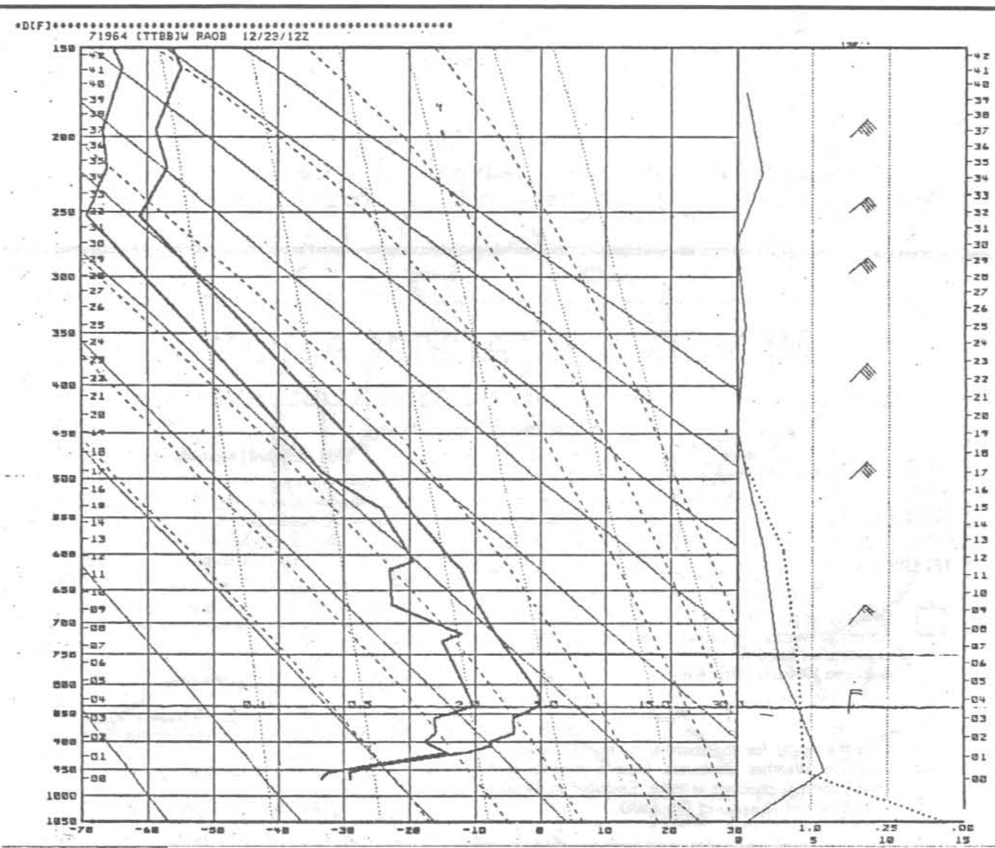

Figure 11. RAOB plot for Whitehorse (YXY), 23/12Z December 1983.

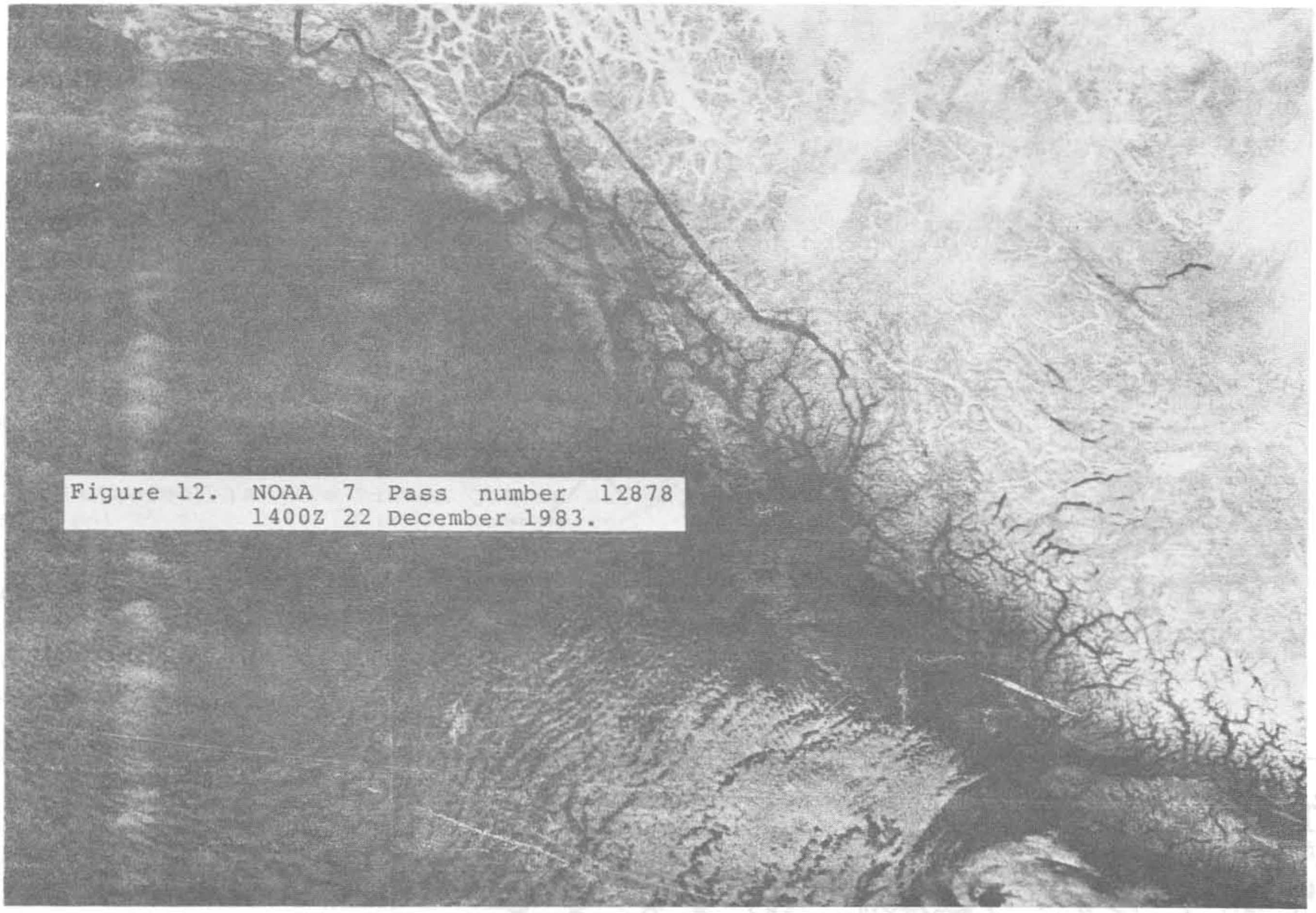

Figure 12. NOAA 7 Pass number 12878
1400Z 22 December 1983.

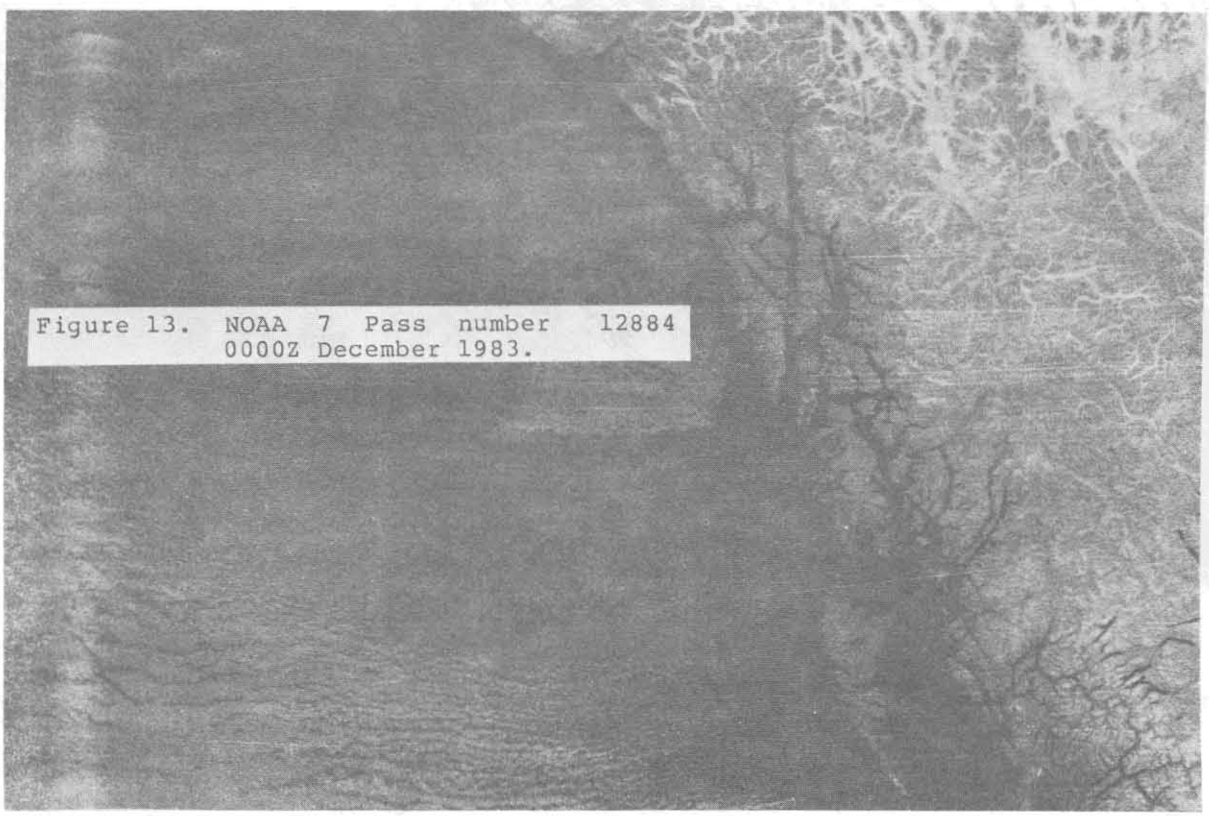

Figure 13. NOAA 7 Pass number 12884
0000Z December 1983.

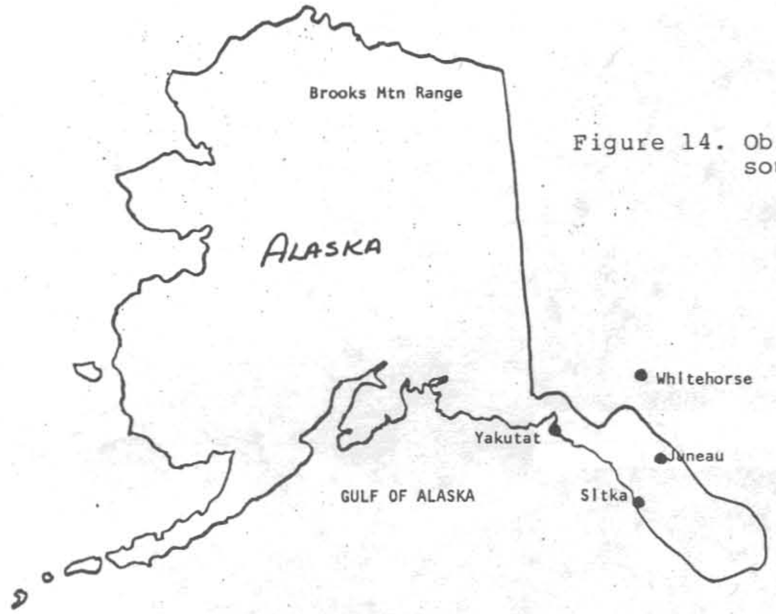

Figure 14. Observing stations across southeastern Alaska.

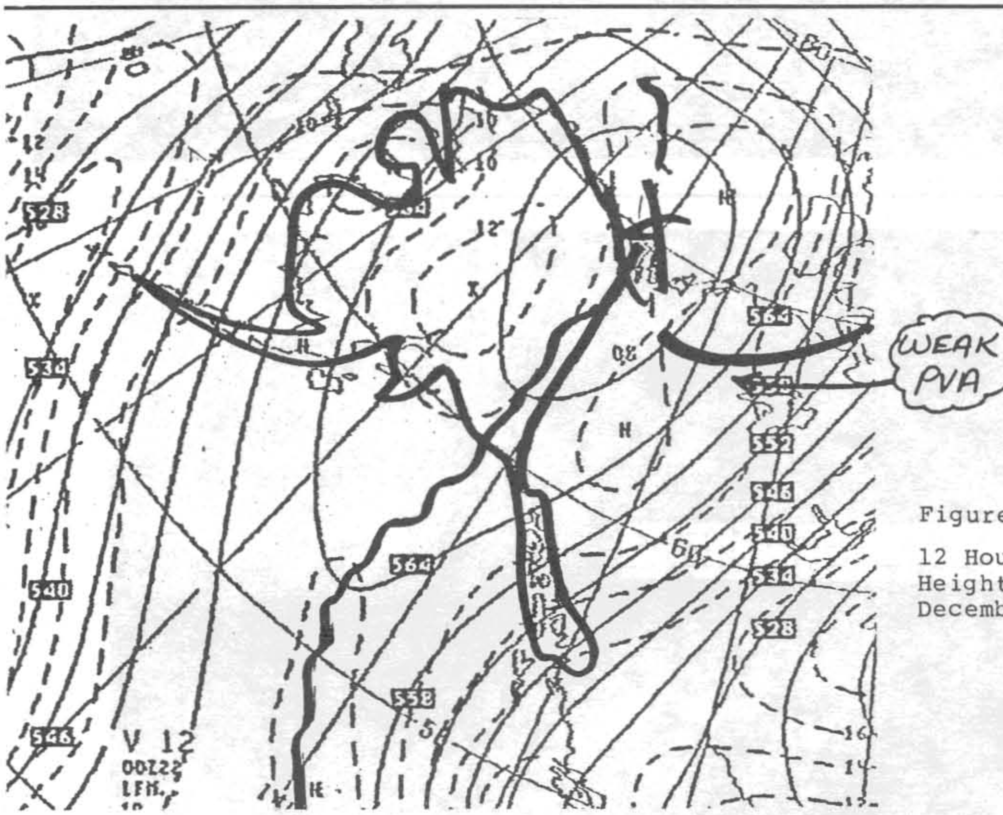

Figure 15.

12 Hour LFM forecast, 500 MB, Heights/Vorticity, Valid 22/00Z December 1983.

ACKNOWLEDGMENTS

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FOOTNOTE

1. Robert W. Jacobson, Jr., received a B.S. in Education from Western Illinois University in 1969 and an M.S. in Atmospheric Science from Colorado State University in 1975. He has worked as a Meteorologist for the National Climatic Data Center in Asheville, NC; at the WSFO in Anchorage, AK, and as Meteorologist-in-Charge of the WSO in Lansing, MI, and is currently the Deputy MIC at WSFO, Juneau, AK.